

# Assessing volcanic risk to the Taranaki Energy Distribution Sector

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- The only oil and gas production in NZ (+distribution)
- Important electricity generation and transmission assets
- Iconic industrial sites

***What is the impact of minor ash-falls on key sites in Taranaki?***



# Current legislative environment

- Lifeline utilities are required to operate, albeit possibly at a reduced level, during and after an emergency.
- How vulnerable are these systems and assets to the effects of an eruption?
- How can their vulnerability be reduced to meet the legislative requirements?



# Interdependencies

- Groups relying on operating electricity networks:
  - Hospitals and medical centres'
  - Emergency operation centres
  - Energy control centres
  - Communication networks
  - Water and sewerage
  - Gas production
  - Liquid fuel pumping and delivery
  - Essential domestic/ commercial/ industrial





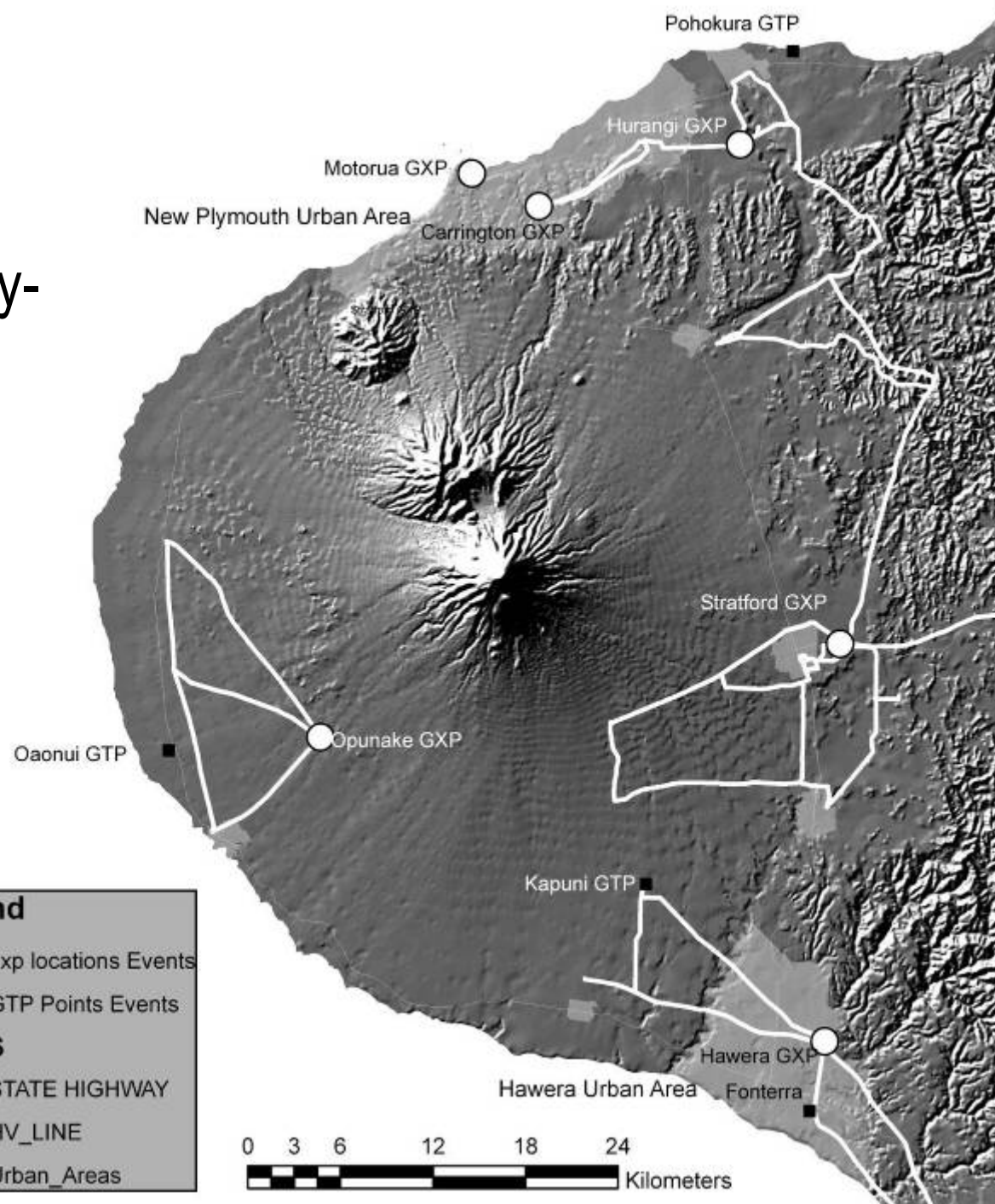
# Taranaki Energy-Distribution Infrastructure

**Legend**

- gxp locations Events
- GTP Points Events

**CLASS**

- STATE HIGHWAY
- HV\_LINE
- Urban\_Areas



Site	Distance from volcano (km)	Bearing from volcano (° from N)	Plant replacement cost (\$ million)
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Whareroa Dairy Factory	41.8	150	1045
Kapuni (Fonterra Lactose)	22.4	155	207
Kapuni (gas treatment plant)	22.4	155	80
Oanui gas treatment plant	24.5	242	
Pohakura gas treatment plant	38.4	29	

Opunake GXP	16	229	3.5-4
Moturora GXP	26.2	355	3.5-4
Carrington GXP	24	6	16.5-17
Huirangi GXP	31.8	31	7.2-8
Stratford GXP	22.6	101	45.8-46.5
Hawera GXP	37.1	144	10.5-11





Loading - heavy falls  
Flashovers  
Isolation in substations  
Auto-recloser functions



## Critical limits:

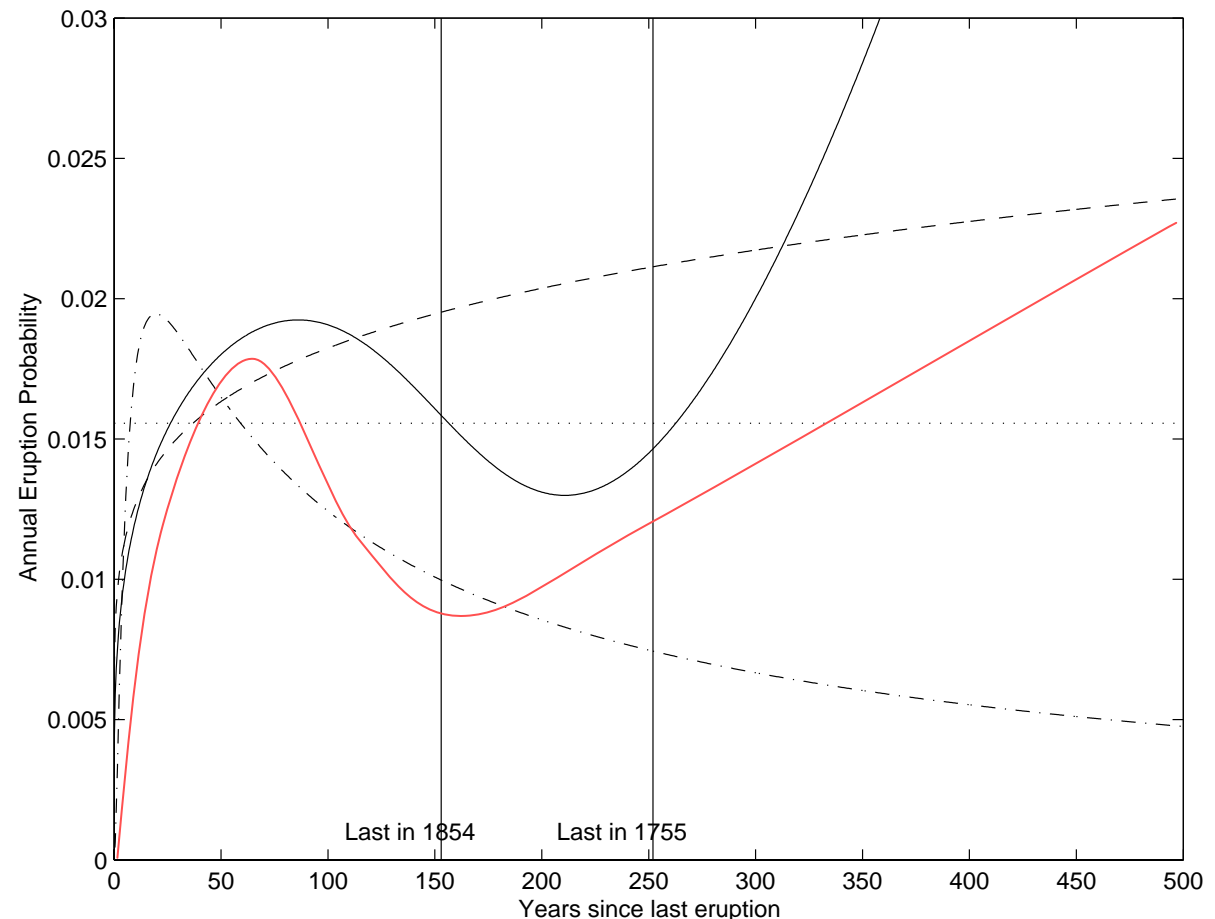
2 mm dry

1 mm wet ash



# Ash fall Forecast: combined

50 year probability of an eruption is **0.52 (+0.15)** for the 1854 scenario, **0.66 (+0.18)** for the 1755 scenario



Dotted = exponential, dot-dash = lognormal, dashed = Weibull, solid = mixture of Weibulls  
Red curve is NS+U, post-10150 model



- Need a method of determining the size (eruptive volume).
- No apparent correlation between tephra thicknesses at Umutekai and the eruption interval before or after.
  - Hence model hazard as rate\*volume.
- Need a frequency-volume curve.
  - thicknesses known
  - Rhoades et al (2002) relation between tephra thickness (T), eruptive volume (V), distance (R) and direction ( $\theta$ ).



$$\log T = 8.67 + 1.13 \log V - 2.38 \log(R + 1.85V^{1/3}) + 1.28 \cos \theta + 0.28 \sin 2\theta + 0.22 \cos 2\theta$$

169 (T is in cm, V in km<sup>3</sup>, R in km)

VOLCANIC HAZARD IN NEW ZEALAND

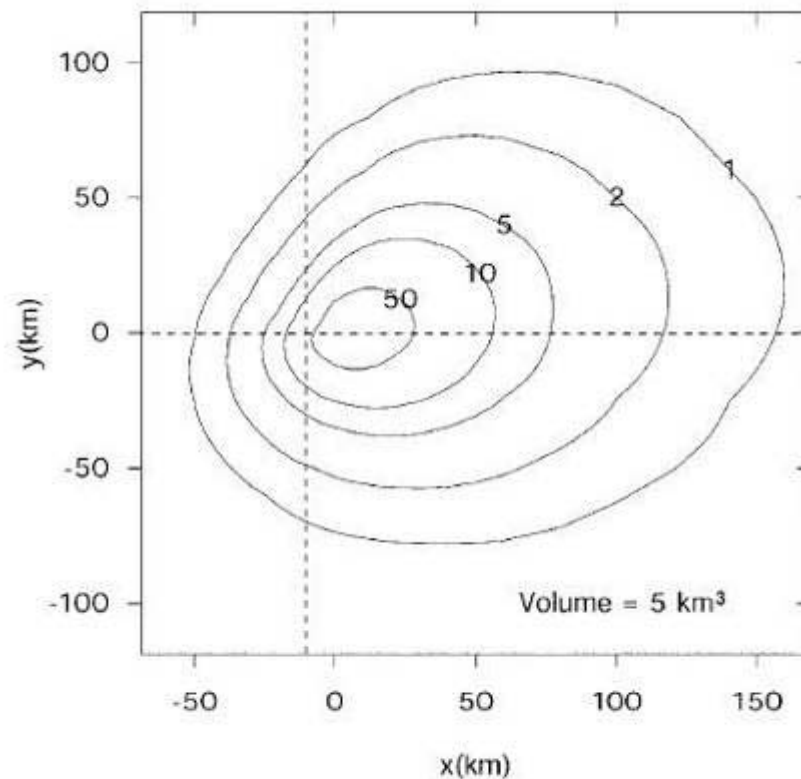
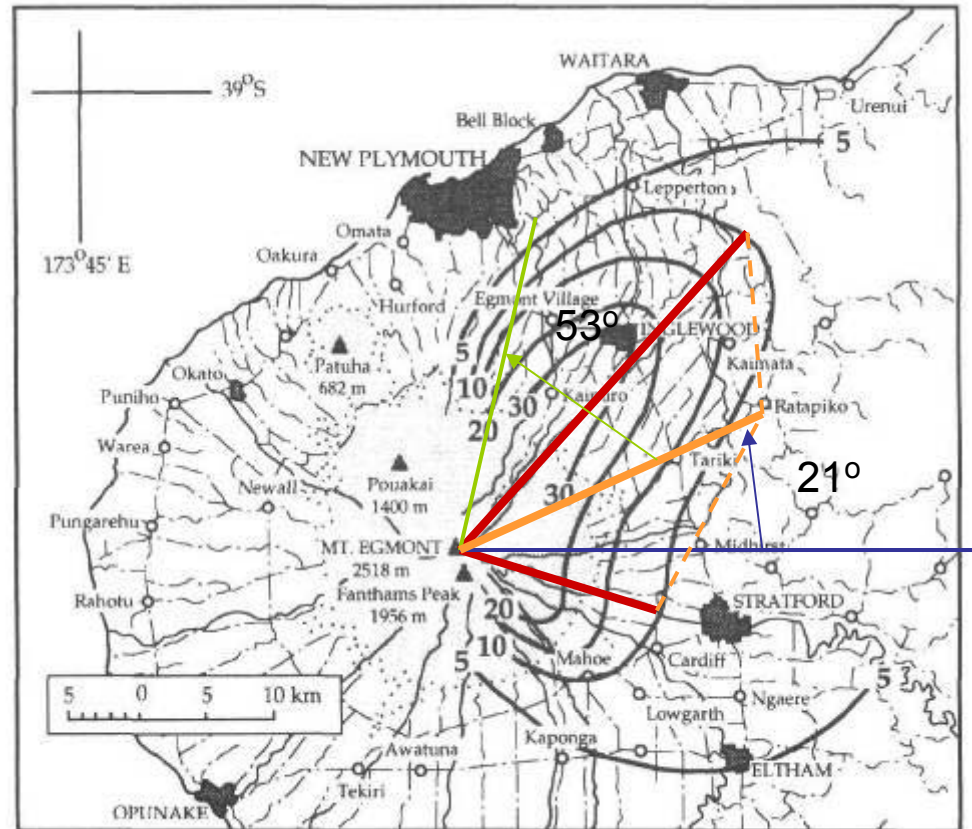


Figure 15. Fitted mean ash thickness distribution (cm) in relation to the centre of deposit in an eruption of volume 5 km<sup>3</sup>, according to relation (11). Intersecting dashed lines mark the expected position of the vent, computed from relation (10).



$\theta$  is measured from the preferred wind direction.  
 $\theta = 21^\circ$  N of E using isopach diagrams for Mt. Taranaki  
 (Alloway et al, 1995),

Lake Umutekai is then  $53^\circ$  from this, making the relation:

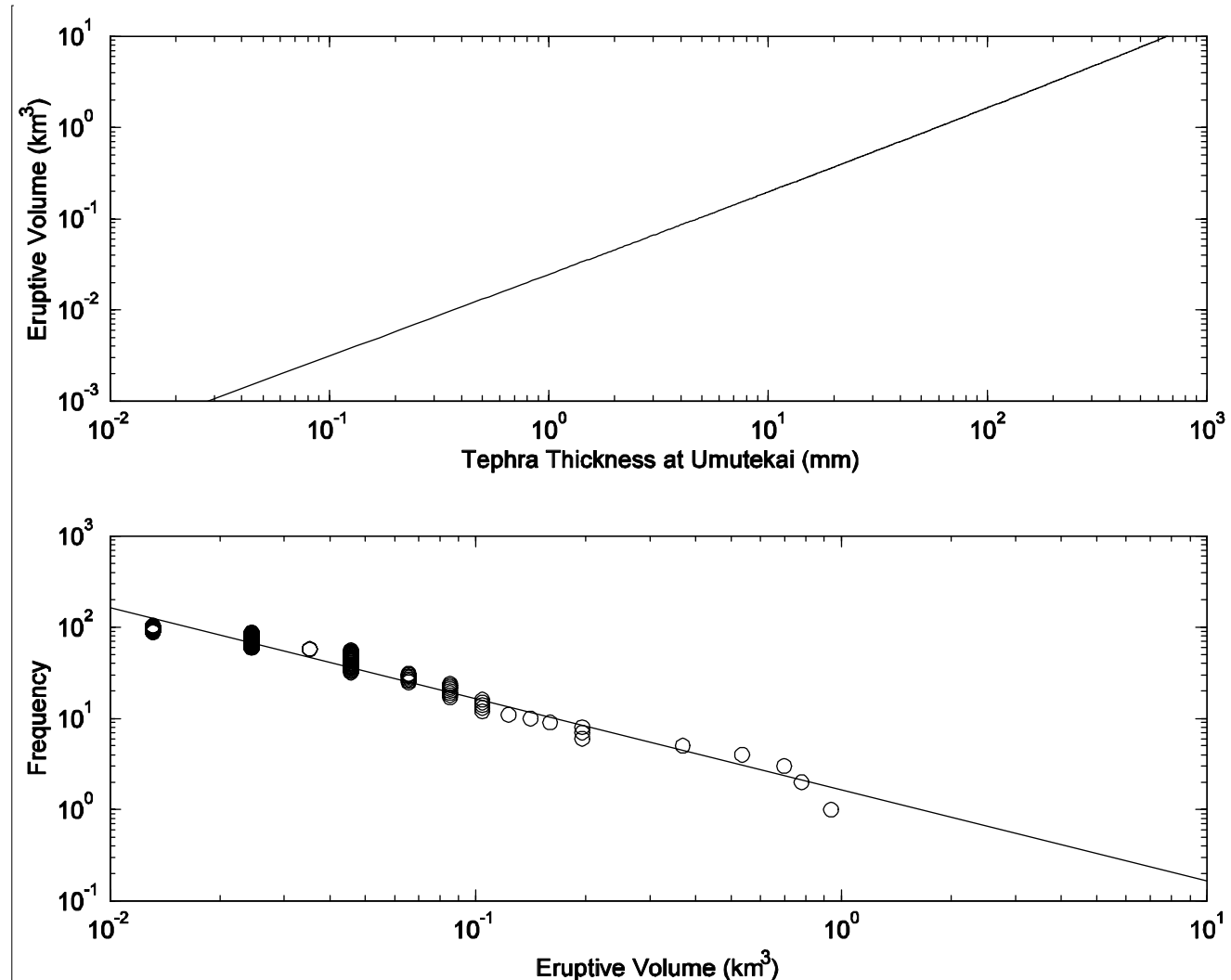


$$\log T = 8.67 + 1.13 \log V - 2.38 \log (R + 1.85 V^{1/3}) + 0.933$$



Umutekai:

53° from  
Preferred  
dispersal  
axis

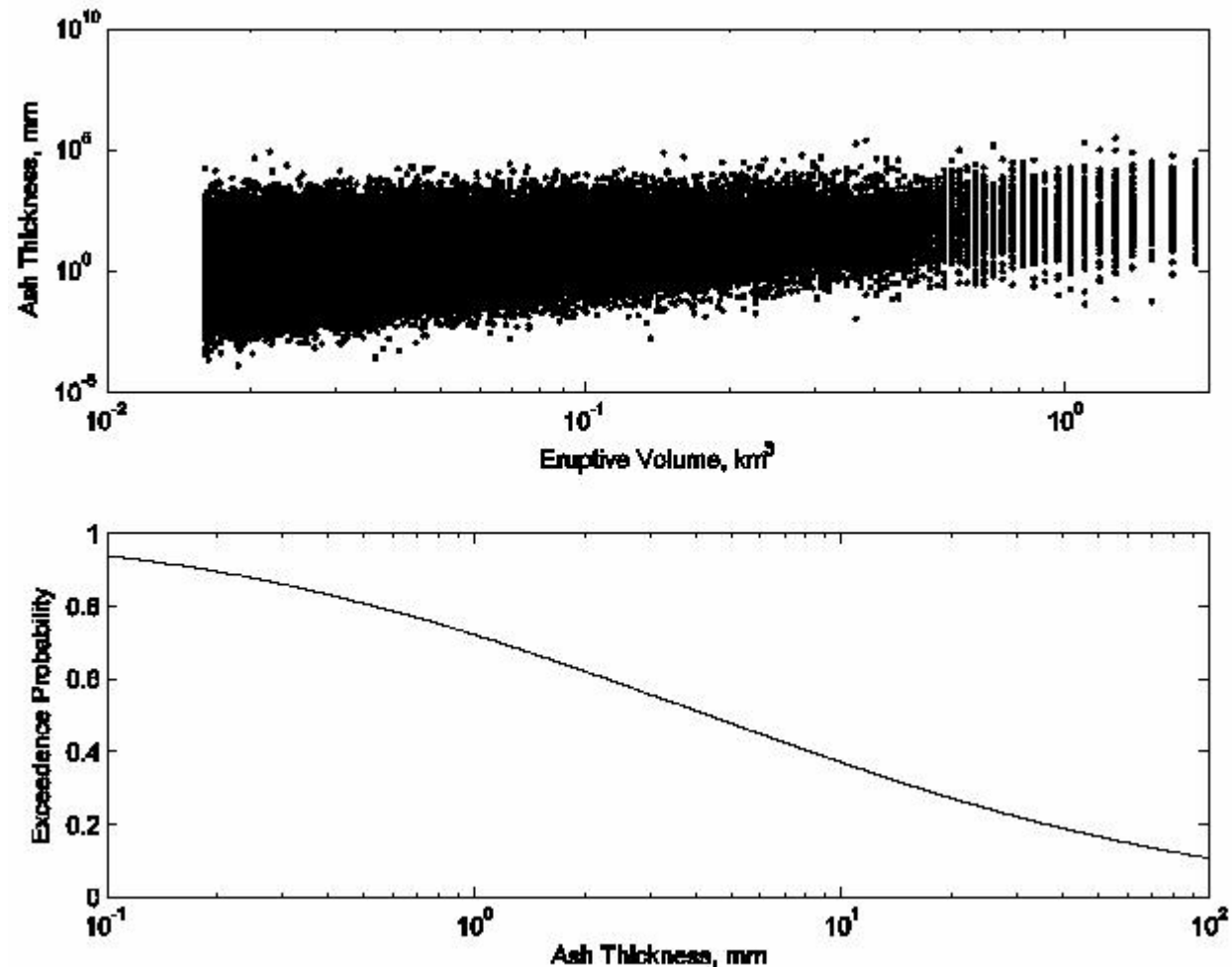


$$P(V > v) = 0.016 v^{-0.9971}, v > 0.016 \text{ km}^3$$



Stratford GXP is  
22.6km distant, at  
 $101^\circ$  from N

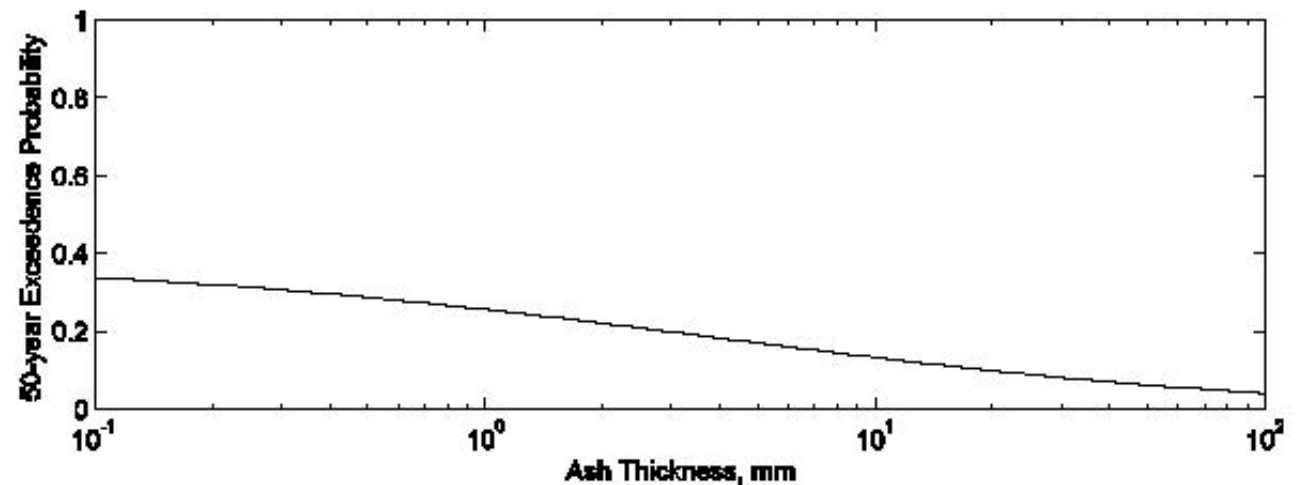
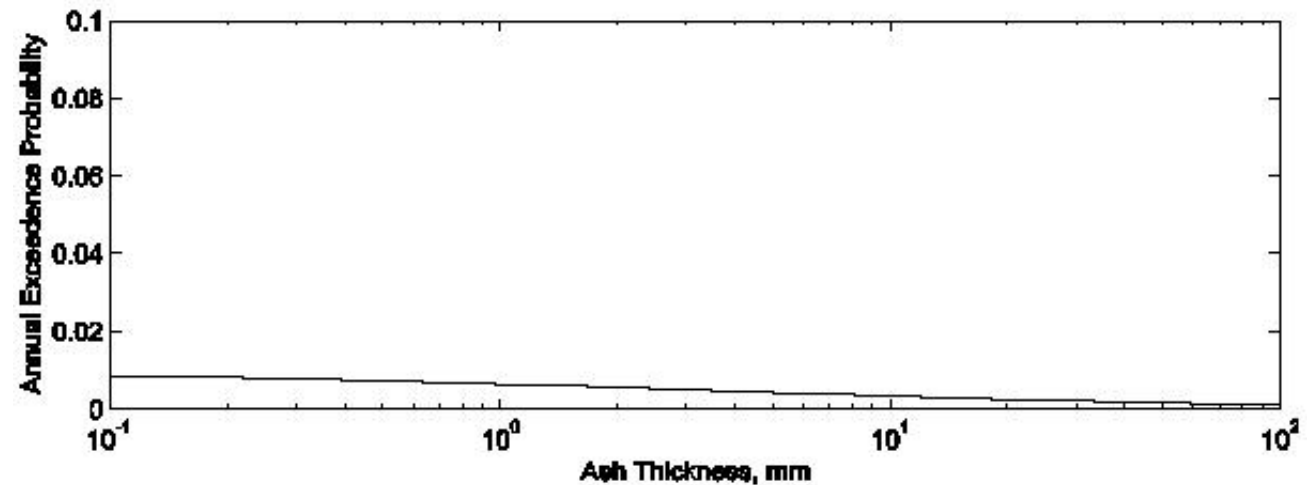
Repeatedly  
drawing a random  
eruption size and  
wind direction, we  
can obtain a  
distribution for the  
fall thickness, given  
an eruption



Combining the annual eruption probability and the thickness probabilities:

Caveat: This is based on the NS+U data only.

So multiply by 1.5



Site	1 mm	5 mm
Whareroa	0.394	0.184
<b>Kapuni</b>	<b>0.538</b>	<b>0.304</b>
Oaonui	0.282	0.112
Pohakura	0.380	0.188
Opunake GXP	0.437	0.225
Moturora GXP	0.398	0.192
Carrington GXP	0.414	0.206
Hurrangi GXP	0.406	0.196
<b>Stratford GXP</b>	<b>0.696</b>	<b>0.462</b>
Hawera GXP	0.432	0.219



	1mm	5mm
Whareroa	0.145	0.068
<b>Kapuni</b>	<b>0.198</b>	<b>0.112</b>
Oaonui	0.104	0.041
Pohakura	0.140	0.069
Opunake GXP	0.161	0.083
Moturora GXP	0.146	0.071
Carrington GXP	0.152	0.076
Hurrangi GXP	0.149	0.072
<b>Stratford GXP</b>	<b>0.256</b>	<b>0.170</b>
Hawera GXP	0.159	0.081

